

Appendices

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This report is available online at:
<http://glc.org/projects/habitat/coastal-ecosystem>

Appendix A Spreadsheet Matrix on Ecological Processes for Harbor

	Open lake	Coastal/nearshore	Watershed (tributaries)
Geomorphic	Glacial processes that shaped lake depth, and form and texture of lake-bottom terrain (ridges, troughs, plains).	Coastal sediment dynamics influencing erosion, transport, and deposition of sediments within harbor areas	Glacial processes that shaped watershed size, topography, sediments, and valley structure.
	Sediment erosion, transport, and deposition dynamics influencing texture of lake-bottom sediments.	Tributary dynamics influencing erosion, transport, and deposition of sediments within coastal/nearshore habitats.	Watershed and valley specific sediment dynamics driving erosion, transport, and deposition of sediments within channel and flood plain.
	Climate change altering seasonal lake storms and wave patterns		
Hydrologic	Seasonal lake mixing and large-scale currents influencing wave patterns	Lake storm surges, seiches, upwellings influencing erosion and impacting harbor structures	Watershed-driven, tributary flow regimes driving erosion and altering harbor flow patterns
	Winter ice-cover regimes.	Tributary inflow regimes influencing clarity, nutrient, and temperature regimes.	
	Altering of harbor structures by dreissenid mussels	Distribution and dynamics of sunken wood debris recruited from coasts and tributaries.	Stream channel interactions with riparian flood-plain ecosystems and river-channel habitats
Biological		Altering of harbor structures by dreissenid mussels	Modifications to riparian vegetation that effect flow patterns and sedimentation
	Nuisance effects from accidental species introductions.	Elimination or disconnection of wetland habitats.	Altered watershed and valley sediment dynamics
Societal	Climate change altering seasonal lake temperatures and ice regimes.	Effects of Piers and breakwalls modifying shoreline currents	Diking and hardening of channel shorelines

	Open lake	Coastal/nearshore	Watershed (tributaries)
Geomorphic	Glacial processes that shaped lake depth, and form and texture of lake-bottom terrain (ridges, troughs, plains).	Glacial processes that shaped topography and texture of lowest river-valley segment, delta, embayment, and coastline.	Watershed- and valley-specific sediment dynamics driving erosion, transport, and deposition of sediments within channel and flood plain.
	Sediment erosion, transport, and deposition dynamics influencing texture of lake-bottom sediments.	Coastal sediment dynamics influencing erosion, transport, and deposition of sediments within coastal habitats.	Glacial processes that shaped watershed size, topography, sediments, and valley structure.
Hydrologic	Distribution and dynamics of floating and sunken wood debris recruited from coasts and tributaries.	Lake storm surges, seiches, upwellings influencing clarity, nutrient, and temperature regimes.	Watershed-driven, tributary flow regimes driving instream clarity, nutrient, and temperature regimes.
	Winter ice-cover regimes.	Tributary inflow regimes influencing clarity, nutrient, and temperature regimes.	Hydrologic sources to riparian ecosystems
Biologic	Restructuring bottom and altering nutrient pathways by nuisance dreissenid mussels.	Dynamic hydrologic connectivity with coastal wetlands.	Modifications to riparian vegetation that effect flood-plain and channel habitats.
	Seasonal lake mixing (both vertical and with nearshore), and large-scale currents influencing clarity, nutrient, and temperature regimes.	Distribution and dynamics of sunken wood debris recruited from coasts and tributaries.	Stream channel interactions with riparian flood-plain ecosystems and river-channel habitats; effects on shading, bank structure, recruitment of woody structure.
Societal	Distribution and dynamics of juvenile fishes produced in coastal/nearshore and tributary habitats.	Distribution and dynamics of juvenile fishes produced in open-lake, coastal/nearshore, and tributary habitats.	Instream dynamics of nutrient pulses in the form of fish eggs and fry (nutrients) imported from open-lake habitat.
		Eutrophication-driven high algal concentrations shading bottom.	Instream distribution of sources of primary production.
	Air- and precipitation-borne contaminants and chemicals (acids).	Piers and breakwalls modifying shoreline processes, and lake influence and exchange with rivermouths and embayments.	Altered watershed and valley sediment dynamics (loads, erosion, transport, deposition).
	Climate change altering seasonal lake temperatures and ice regimes.	Municipal and industrial wastewater discharges.	Diking and hardening of channel shorelines that reduces habitat complexity in channel and flood plain.
	Increased predation by hatchery-reared salmonids.	Nonpoint runoff from local or tributary watershed urban or agricultural landscapes.	Modified watershed landscape hydrology changing instream clarity, nutrient, and temperature regimes.
	Nuisance effects from accidental species introductions.	Reduced hydrologic connectivity with coastal wetlands.	Point- and nonpoint-source inputs of contaminants.
	removal of dead trees; commercial log harvest	Increased predation by hatchery-reared salmonids.	Development within flood-plain valleys that eliminates wetland services.

	Open lake	Coastal/nearshore	Watershed
Geomorphic	Sediment composition and interstitial spacing that drives bioavailability via contaminant burial or resuspension	Topography/hydraulics of lowest river-valley segment, embayment, and coastline influencing contaminant retention/ exchange with open lake.	Substrate adherence and leaching from substrate.
		Substrate adherence and leaching from substrate.	Watershed substrate, area and slope
		Coastal sediment dynamics driving erosion, transport, and deposition of contaminants within coastal/nearshore habitats.	Groundwater hydrogeology.
Hydrologic	Seiche	Currents that drive contaminant dispersion and deposition.	Tributary flow regime driving instream dispersal.
	Large-scale currents that drive contaminant dispersion and deposition.	Persistence within the system due to physical and chemical properties determining contaminant half-lives.	Groundwater flow paths.
	Seasonal lake mixing that drives contaminant resuspension from sediments.	Seasonal lake mixing that drives contaminant resuspension from sediments.	Overland flow, infiltration, and associated contaminant transport to surface-water and groundwater systems.
Biological	Differential transport and persistence of different microbes.	Development cycle of cyanobacteria.	Natural sources, such as birds and wildlife.
		Survival and naturalization of fecal indicator bacteria and pathogens.	Differential transport and persistence of different microbes.
		Oxidation and reduction of chemicals and compounds.	Chemical pollutant degradation.
Societal	Atmospheric contamination.	Storm drains and urban runoff that deliver contaminants.	Chemical use (fertilizers, road salt, pesticides, etc)
	Air- and precipitation-borne contaminants and chemicals.	Substrate adherence and leaching from substrate.	Altered sediment dynamics.
	Boat and ship waste dumping.	Point-source runoff from industrial land use; infrequent accidental loadings.	Failing or leaking municipal sanitary waste systems, combined-sewer overflows, and sanitary-sewer overflows.
		Nonpoint runoff from local urban and agricultural landscapes.	Modified hydrology (drains, wetland removal, impervious surfaces).
		Placement of water intakes.	Water-well placement.
		Storm drains that deliver biological contaminants.	Point-source runoff from industrial land use;
		Shoreline septic systems that deliver biological contaminants.	Nonpoint runoff from local urban and agricultural landscapes.
			Wastewater-treatment-plant effluent discharges.

	Open lake	Coastal/nearshore	Watershed
Geomorphic	Substrate adherence and leaching from substrate.	Substrate adherence and leaching from substrate.	Substrate adherence and leaching from substrate.
	Sediment composition and interstitial spacing that drives bioavailability via contaminant burial or resuspension.	Topography/hydraulics of river-valley segment, embayment, and coastline, altering contaminant retention/exchange	Interaction among hydrologic regime, geomorphic), and wood-recruitment processes that create patterns in mesohabitats (eg. Pools)
	Glacial processes that shaped lake depth, and form and texture of lake-bottom terrain (ridges, troughs, etc)	Glacial processes that shaped topography and texture of lowest river-valley segment, delta, embayment, and coastline.	Glacial processes that shaped watershed size, topography, sediments, and valley structure.
	Sediment erosion, transport, and deposition dynamics influencing texture of lake-bottom sediments.	Coastal/tributary sediment dynamics driving erosion, transport, and deposition of contaminants within coastal habitats.	Watershed-/valley-specific sediment dynamics driving erosion, transport, and deposition of sediments within channel and flood plain.
	Seasonal lake mixing that drives contaminant resuspension from sediments.	Large-scale currents, upwellings, and storm-induced surges that drive contaminant and pathogen dispersion and deposition.	Tributary flow regime driving instream dispersal and transport of chemicals and pathogens.
Hydrologic	Large-scale currents that drive contaminant and pathogen dispersion and deposition.	Groundwater flow and delivery of contaminants and pathogens.	Groundwater flows that contribute dissolved contaminants to tributaries.
	Persistence within the system due to physical/chemical properties determining contaminant half-lives.	Topography/hydraulics of river-valley segment, embayment, and coastline influencing water retention and exchange with open lake.	Watershed-driven, tributary flow regimes driving instream clarity, nutrient, and temperature regimes.
	Changing water levels that effects water and sediment temperatures	Tributary inflow regimes influencing clarity, nutrient, and temperature regimes.	Surface runoff that may deliver or disturb sediments.
	Fish life history, foraging ecology, and metabolism.	Methylation of mercury by bacteria.	Presence, survival, and reproducibility of pathogens.
	Methylation of mercury by bacteria.	Impact of terrestrial and aquatic invasive species	Toxicity from water- and sediment-related contaminants.
Biological	Distribution and dynamics of floating and sunken wood debris recruited from coasts and tributaries.	Distribution and dynamics of juvenile fishes produced in open-lake, coastal/nearshore, and tributary habitats.	Dynamics of aquatic and wetland macrophytes, and terrestrial plants.
	Restructuring bottom and altering nutrient pathways by nuisance dreissenid mussels.	Piers and breakwalls modifying shoreline processes	Channelization that modifies contaminant deposition vs dispersal to coastal and offshore zones.
	Climate change altering seasonal lake temperatures and ice regimes.	Eutrophication-driven high algal concentrations shading bottom.	Point-source and nonpoint source runoff from industrial and agricultural land use
	Siting of offshore spoil areas for contaminated dredging materials.	Reduced hydrologic connectivity with coastal wetlands.	Diking/hardening of channel that reduces habitat complexity in channel & flood plain.
	Nuisance effects from accidental species introductions.	Fishery practices determining targeted species and locations.	Development within flood-plain in valleys that eliminates wetland services.

Appendix E Spreadsheet Matrix on Ecological Processes for Swimming

	Open lake	Coastal/nearshore	Watershed
Geomorphic		Topography and hydraulics of embayment, and coastline influencing contaminant retention and exchange with open lake.	Sediment dynamics.
		Substrate adherence and leaching from substrate.	Watershed area and slope.
		Coastal sediment dynamics driving erosion, transport, and deposition of contaminants within coastal/nearshore habitats.	Groundwater hydrogeology.
Hydrologic	Large-scale currents that drive contaminant dispersion and deposition.	Currents that drive contaminant dispersion and deposition.	Tributary flow regime driving instream dispersal.
	Effects of seiches	Persistence within the system due to physical and chemical properties determining contaminant half-lives.	Groundwater flow paths.
		Dispersion and physical processing.	Differential transport and persistence of different microbes.
		Lake-groundwater interaction.	Overland flow, infiltration, and associated contaminant transport to surface and groundwater systems.
Biological		Natural sources, such as birds and wildlife.	Natural sources, such as birds and wildlife.
		Cladophora growth and decay.	Survival, refugia, and naturalization of fecal indicator bacteria and pathogens.
Societal	Boat and ship waste dumping.	Storm drains that deliver biological contaminants.	Manure application and runoff into nearby waters.
		Shoreline septic systems that deliver biological contaminants.	Failing or leaking municipal sanitary waste systems, combined-sewer overflows, and sanitary-sewer overflows.
		Substrate adherence and leaching from substrate.	Wastewater-treatment-plant effluent discharges.
		Impervious surfaces in beach catchment.	Altered sediment dynamics.
		Contaminated nearshore groundwater.	Channelization and artificial reservoirs that modify contaminant deposition versus dispersal to coastal/nearshore and offshore zones.

Appendix F List of Workshop Participants

First	Last	Organization
Randy	Lehr	Northland College
Terry	Brown	University of Minnesota - Duluth
Amy	Eliot	University of Wisconsin - Lake Superior Research Institute
Lucinda	Johnson	University of Minnesota - Duluth
Thomas	Cermak	Pennsylvania Sea Grant
Anthony	Foyle	Pennsylvania State Erie - The Behrend College
Frank	Lichtkoppler	Lake County, OH
Tom	Bridgeman	University of Toledo
Gene	Clark	Wisconsin Sea Grant
Titus	Seilheimer	Wisconsin Sea Grant
Anna	McCartney	Pennsylvania Sea Grant
David	Skellie	Pennsylvania Sea Grant
Philip	Willink	Shedd Aquarium
Becky	Sapper	Lake Superior National Estuarine Research Reserve and University of Wisconsin - Extension
David	Bolgrien	U.S. Environmental Protection Agency
Bradley	Frazier	Bureau of Indian Affairs
Ulf	Gafvert	National Park Service - Apostle Island National Lakeshore
Jay	Glase	National Park Service - Apostle Island National Lakeshore
Ted	Koehler	U.S. Fish and Wildlife Service - Coastal Program
Ted	Angradi	U.S. Environmental Protection Agency
Brenda	Moraska Lafrancois	National Park Service
Paul	Seelbach	U.S. Geological Survey - Great Lakes Science Center
Julie	Van Stappen	National Park Service - Apostle Islands National Lakeshore
David	VanderMeulen	National Park Service - Apostle Islands National Lakeshore
Mark	Vinson	U.S. Geological Survey - Great Lakes Science Center, Ashland Station
Jon	Hortness	U.S. Geological Survey
Lisa	Fogarty	U.S. Geological Survey
Amie	Brady	U.S. Geological Survey - Ohio
Mark	Rogers	U.S. Geological Survey
Richard	Bartz	U.S. Geological Survey
Kristi	Arend	Old Woman Creek National Estuarine Research Reserve
Brad	Potter	Upper Midwest and Great Lakes Landscape Conservation Cooperative
Rachael Franks	Taylor	National Oceanic and Atmospheric Administration - Coastal Zone Management
Thomas	Bergman	Comprehensive Planning/Land & Zoning - Iron County, WI
Larry	MacDonald	Mayor, City of Bayfield
Diane	Nelson	Environmental Works Division - City of Superior

Steve	Roberts	City of Superior, WI
Timothy	Huemmrich	Bureau of Sewers - City of Erie, PA
Karen	Tobin	Department of Health - Erie County, PA
Jake	Welsh	Department of Planning - Erie County, PA
Joe	Cappel	Toledo-Lucas County Port Authority
Steve	Lavalley	Wisconsin Department of Natural Resources - Water Division
Ben	Brockschmidt	Illinois Chamber of Commerce
John	Matousek	Michigan Department of Environmental Quality
Adam	Mednick	Wisconsin Department of Natural Resources
Daniel	Injerd	Illinois Department of Natural Resources
Steve	Greb	Wisconsin Department of Natural Resources
Vic	Santucci	Illinois Department of Natural Resources
Diane	Tecic	Illinois Department of Natural Resources
Matt	Preisser	Michigan Department of Environmental Quality
Timothy	Bruno	Pennsylvania Department of Environmental Protection
MD	Hoque	New York Department of Environmental Conservation
Jim	Lehnen	New York Department of Environmental Conservation
Harry	Leslie	Pennsylvania Department of Conservation and Natural Resources
Jacob	Moore	Pennsylvania Department of Environmental Protection
Barry	Pendergrass	New York Department of State - Office of Planning and Development
Judy	Beck	Lake Michigan League of Women Voters
Mary	Khoury	The Nature Conservancy
Douglas	Pearsall	The Nature Conservancy
Kristy	LaManche	Finger Lakes-Lake Ontario Watershed Protection Alliance
Sandra	Kosek-Sills	Ohio Lake Erie Commission
Jason	Laumann	Northwest Wisconsin Regional Planning Commission
Victoria	Pebbles	Great Lakes Commission
Matt	Doss	Great Lakes Commission
Jennifer	Wasik	Metropolitan Water Reclamation District of Greater Chicago
Tom	Slawski	Southeastern Wisconsin Regional Planning Commission
Lacey	Hill-Kastern	Bad River Band of Lake Superior Chippewa- Natural Resources Department
Jessica	Strand	Bad River Band of Lake Superior Chippewa- Natural Resources Department
Brian	Napont	Grand Traverse Band of Ottawa and Chippewa Indians